Department of Mechatronics Engineering
School of Engineering
Faculty of Science, Technology and Architecture
Bachelor of Technology in Mechatronics Engineering, Batch 2025 Onwards

THIRD SEMESTER

MEEXXXX ENGINEERING ECONOMICS [3 0 0 3]

Concept and Value Analysis, Economic Decision Making, Types of Estimates, Accounting and Control, Elements of Cost, Prime Cost, Overheads, Types of Cost, Process Cost & Cost of Production, Break Even Analysis, Inventory Control & Management, EOQ, Financial Analysis, Simple payback, Return on Investment, NPV (Net Present Value), IRR (Internal rate of Return), Life Cycle Cost Method, Sensitivity Analysis, Project Financing Options. Budget and Budgetary Control, Concept of Budgeting, Type of Budgets. Risk - Risk vs Return, System Concept and Value Analysis, System Analysis & System Engineering, Value Analysis. Replacement Analysis, Depreciation.

References:

1. R. Panneerselvam, *Engineering Economics*, 2nd ed. New Delhi, India: PHI Learning, 2020.
2. J. L. Riggs, D. D. Bedworth, and S. U. Randhawa, *Engineering Economics*, 4th ed. New York, NY, USA: McGraw-Hill, 2023.
3. P. L. Mehta, *Managerial Economics*. New Delhi, India: Sultan Chand & Sons, 2024.
4. E. L. Grant, W. G. Ireson, and R. S. Leavenworth, *Principles of Engineering Economic Analysis*, York, NY, USA: Wiley, 2024.
5. G. J. Thuesen, W. J. Fabrycky, and H. G. Thuesen, *Engineering Economy*, 2023.

MCE2101 LINEAR INTEGRATED CIRCUITS [3 1 0 4]

Operational amplifier- Block diagram, characteristics, Open loop, and closed loop configurations. Inverting and Non-Inverting amplifier: Voltage follower, summing, scaling and averaging amplifiers, AC amplifiers; Linear applications of OPAMP Waveform Generators: Sine-wave generators, square/triangle/Saw-tooth wave generators; IC 555 timer- Monostable operation and its applications, a stable operation and its applications; Phase-locked loop and its applications, Voltage controlled oscillator, Active filters & voltage regulator-low pass filter, high pass filter, band pass filter and band reject filters, All pass filters, switched capacitor filters; Voltage regulators, linear voltage regulators using OPAMP – IC regulators (78xx, 79xx, LM 337, 723), Digital-to Analog-Conversion, Analog-to-Digital Conversion

References:

1. Roy Choudhury and S. Jain, *Linear Integrated Circuits*, 5th ed. New Delhi, India: New Age International Publishers, 2018.
2. S. Salivahanan and V. S. K. Bhaaskaran, *Linear Integrated Circuits*, 3rd ed. New Delhi, India: Tata McGraw-Hill (India), 2018.
3. R. A. Gayakwad and S. Rekha, *Op-Amps and Linear Integrated Circuits*, Rev. 4th ed. New Delhi, India: Pearson Education,2024.
4. R. F. Coughlin and F. F. Driscoll, *Operational Amplifiers and Linear Integrated Circuits*, 6th ed. Upper Saddle River, NJ, USA: Prentice Hall, c. 2022.

MCE2102 EMBEDDED CONTROLLERS [3 1 0 4]

Comparison between microprocessor and microcontroller, Introduction to embedded controllers, Architecture of microcontroller: Register Banks; Programming model, Pin diagram & details, I/O Ports & details. Assembly Language Programming: Assembler Directives, Addressing Modes, Instruction set, calculation of delay, delay programs. Timers, Counters, Serial Communication, Interrupts, Programming examples. Programming in Embedded C: Data types in embedded C, arithmetic & logic operators, control statements and loops in embedded C, functions & arrays, Hardware Interfacing: Stepper Motor, Seven Segment Display, LCD, Design of Microcontroller based systems: Introduction to other Microcontroller families (PIC, AVR and ARM).

References:

1. M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*, 2nd ed. Harlow, U.K.: Pearson New International Edition, 2014.
2. K. J. Ayala, *The 8051 Microcontroller: Architecture, Programming, and Applications*, 3rd ed. Boston, MA, USA: Cengage Learning, 2019.
3. A. V. Deshmukh, *Microcontrollers: Theory and Applications*, Rev. ed. New Delhi, India: McGraw-Hill Education (India), 2017.
4. K. U. Rao and A. Pallavi, *The 8051 and MSP430 Microcontrollers: Architecture, Programming and Applications*, 1st ed. New Delhi, India: Wiley India, 2019.

MCE2103 STRENGTH OF MATERIALS [3 0 0 3]

Stress and Strain of Solids, Deformation of simple and compound bars, Hooke's law, Stress-Strain diagrams for materials, Elongation of tapering bars of circular and rectangular cross sections, Saint Venant's principle, Thermal stress, Elastic constants, Strain energy, Analysis Biaxial state of stresses, Stresses on inclined plane, Principal planes and stresses, Mohr's circle of biaxial stresses, Theory of Failure. Shear force and Bending Moment in Cantilever, Simply supported and Overhanging beams, Theory of simple bending, Effect of shape of beam section on stress induced with different load, Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections, Torsion: Analysis of torsion of circular bars, Shear stress distribution for Solid and hollow circular section, Stepped shaft, Twist and torsion stiffness, Introduction, short and long columns. Euler's theory; Assumptions, Buckling load for different end conditions, Limitations of Euler's theory. Rankine-Gordon's formula for columns.

References:

1. E. P. Popov, *Engineering Mechanics of Solids*, 2nd ed. New Delhi, India: Prentice-Hall of India, 2022.
2. S. M. A. Kazimi, *Solid Mechanics*, Rev. ed. New Delhi, India: Tata McGraw-Hill, 2019.
3. R. C. Hibbeler, *Mechanics of Materials*, 11th ed. Boston, MA, USA: Pearson, 2022.
4. F. P. Beer, E. R. Johnston Jr., J. T. Dewolf, and D. F. Mazurek, *Mechanics of Materials*, 6th ed. New Delhi, India: McGraw-Hill Education (India), 2023.
5. B. C. Punmia, A. K. Jain, and A. K. Jain, *SMTS-I Strength of Materials*, 10th ed. New Delhi, India: Laxmi Publications, 2018.

MCE2104 MANUFACTURING TECHNOLOGY [3 1 0 4]

Metal Casting Process: Classification of metal casting, Pattern Allowances, Molding Materials, Gating system design. Casting defects: Causes and remedies, Inspection of castings. Introduction to Machine Tools: Classification of machine tool, Mechanics of Metal Cutting: Principles of metal machining, cutting tools and tool materials, tool signature, mechanics of chip removal, tool wear, tool life, economics of machining. Metal Joining Processes: Principle of welding, soldering, Brazing and adhesive bonding. Classification of welding and allied processes. Resistance welding: Spot, Projection and seam welding

process, atomic hydrogen, ultrasonic, Plasma and laser beam welding, Electron beam welding, and special welding process e.g. TIG, MIG, friction and explosive welding. Metal Shaping and Forming: Metal working, Elastic and plastic deformation, Hot and cold working, Rolling, Principle and operations, Forging, Forging operations, extrusion, Wire, and tube drawing processes. Forging: Principle of forging tool design,

References:

1. S. Kalpakjian and S. R. Schmid, *Manufacturing Engineering and Technology*, 9th ed. Upper Saddle River, NJ, USA: Pearson, 2025.
2. A. Ghosh and A. K. Malik, *Manufacturing Science*, 2nd ed. New Delhi, India: Affiliated East-West Press, 2020.
3. P. C. Sharma, *A Textbook of Production Technology*, Rev. 8th ed. New Delhi, India: S. Chand & Company, 2024.
4. R. K. Jain, *Production Technology: Manufacturing Processes, Technology and Automation*, 19th ed. New Delhi, India: Khanna Publishers,2022.
5. P. N. Rao, *Manufacturing Technology, Volume 1: Foundry, Forming and Welding*, 5th ed. New Delhi, India: McGraw Hill Education, 2023.

MCE2105 KINEMATICS AND DYNAMICS OF MACHINES [3 1 0 4]

Basic Concepts: Mechanism and machine, four bar mechanism, Kutzbach criterion, Grashoph's law, inversions, transmission angle, toggle position and mechanism, Mechanical advantage, snap action mechanism, indexing mechanism. Position analysis: using graphical method, algebraic method. Velocity analysis, acceleration analysis, using graphical method, analytical method, and I-Centre method. Synthesis of linkages: function generation and path generation, graphical method– two- and three-point synthesis, freudenstein's equation. Static analysis and Dynamic analysis: Equilibrium of four force members, four link mechanism, dynamically equivalent system. Gears and gear train: introduction, planetary or epicyclic gear train, differentials. Gyroscope: effect of gyroscopic couple on aeroplane, naval ship, stability of a four wheel and two-wheel drive moving in a curved path.

References:

1. S. S. Rattan, *Theory of Machines*, 5th ed. New Delhi, India: McGraw Hill Education (India), 2019.
2. J. J. Uicker, Jr., G. R. Pennock, and J. E. Shigley, *Theory of Machines and Mechanisms*, 6th ed. Cambridge, U.K.: Cambridge Univ. Press, 2023.
3. R. L. Norton, *Kinematics and Dynamics of Machinery (SI Units)*. New York, NY, USA: McGraw-Hill Higher Education, 2020.
4. K. Russell, J. Q. Shen, and R. S. Sodhi, *Kinematics and Dynamics of Mechanical Systems: Implementation in MATLAB® and Simscape Multibody™*, 3rd ed. Boca Raton, FL, USA: CRC Press, 2022.

MCE2130 EMBEDDED CONTROLLERS LAB [0 0 2 1]

Introduction to Microcontroller, arithmetic instructions, array handling and code conversions, bit manipulations and logic instructions, timer/counter programming, serial communication and interrupts, interfacing ADC, interfacing stepper motor, interfacing DAC, interfacing buzzer, interfacing seven segment display, interfacing LCD, implementing a traffic light controller.

References:

1. M. Fisher, *ARM® Cortex® M4 Cookbook*, 1st ed., Place of publication: Publisher. 2016
2. A. N. Sloss, D. Symes, and C. Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, Amsterdam, Netherlands: Elsevier, 2004.

3. M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, *The 8051 Microcontroller and Embedded Systems Using Assembly and C*, 2nd ed., Upper Saddle River, NJ, USA: Pearson Education, 2010.
4. M. Wolf, *Computers as Components: Principles of Embedded Computing System Design*, 4th ed., Cambridge, MA, USA: Morgan Kaufmann Publishers, 2016.
5. J. Yiu, *The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors*, 3rd ed., Amsterdam, Netherlands: Elsevier, 2013.
6. P. Marwedel, *Embedded System Design*, 2nd ed., Berlin, Germany: Springer, 2011

MCE2131 PLC LAB [0 0 4 2]

Introduction of PLC, study basic components, networking and different programming technique of PLC. Study NO, NC and holding circuit programs, Implementation of Ladder program for timers, counters, math, logical and program control instructions. Study different applications using ladder logic. Analog PLC operations – Accessing Analog inputs and control analog outputs, Conveyor control Systems, Stepper Motor Control, Traffic light Control, Lift Control, Bottling Plant, Mini project.

References:

1. F. D. Petruzella, *Programmable Logic Controllers*, 6th ed. New York, NY, USA: McGraw-Hill Higher Education, 2022.
2. J. W. Webb and R. A. Reiss, *Programmable Logic Controllers: Principles and Applications*, 5th ed. New Delhi, India: Prentice-Hall of India (PHI), c. 2023.
3. A. Fassih, *A Practical Handbook to Programmable Logic Controller*, 1st ed. London, U.K.: New Generation Publishing, 2022.
4. W. Bolton, *Programmable Logic Controllers*, 6th ed. Oxford, U.K.: Elsevier (Newnes), 2019.

FOURTH SEMESTER

MAS21XX STATISTICS & PROBABILITY [3 0 0 3]

Probability Theory and Random Variables: Probability (Only One Lecture), Random variables, Cumulative distribution functions, Discrete random variables, Continuous random variables, Independent random variables, Probability mass and density functions, Expectation of random variables, Chebyschev's inequality, Central limit theorem. Probability distribution: Binomial, Poisson, Uniform, Normal, Exponential Theory of Estimation: Maximum Likelihood and method moment estimation, Sufficient statistics, Bayesian estimation, Confidence intervals for means. Tests of Statistical Hypothesis: Introduction, Parameter and Statistic, Standard error, Statistical hypotheses, Critical region, Tests of hypotheses and significance, Type I and Type II errors, level of significance. level of significance, Test about one mean, Test about equality of two means, Test of variances, Chi square test, Analysis of Variance.

References:

1. A. M. Goon, M. K. Gupta, and B. Dasgupta, *An Outline of Statistical Theory, Volume II (Statistical Inference)*, 2nd ed. Calcutta, India: The World Press, 2013.
2. M. G. Kendall and A. Stuart, *The Advanced Theory of Statistics, Volume II*, 3rd ed. London, U.K.: Charles Griffin & Co. Ltd., 2020.
3. G. Casella and R. L. Berger, *Statistical Inference*, 2nd ed. Boca Raton, FL, USA: CRC Press, 2024.
4. R. V. Hogg and E. A. Tanis, *Probability and Statistical Inference*, 3rd ed. New York, NY, USA: Macmillan Publishing Co., 2015.
5. W. Feller, *An Introduction to Probability Theory and Its Applications, Volume 1*, 3rd ed. New York, NY, USA: John Wiley & Sons, 2021.

MBBXXXX PRINCIPLE OF MANAGEMENT [3 0 0 3]

Management: Definition, Functions, Concept, Scope of Management, Nature of Management, Levels of Management, Managerial Skills, Roles of a Manager, Difference between Management and Administration Evolution of Management Thoughts: Classical Approach- scientific management, Administrative Management and Bureaucracy. Neo-Classical Approach- Human relations movement and Behavioural approach. Modern Approach- Quantitative approach, Systems approach, and Contingency approach. Forms of organization – Sole Proprietorship, Partnership, Co-operative Organization, and Company. Functions of Management: Planning: Concept, Importance, Strategies, Planning Premises; Decision making, Management by Objectives (MBO), Process of Planning. Organizing: Concept, Importance, Process of Organizing, Types of Organizational Structures, Span of Management, Line and Staff Relationship, Centralization and Decentralization. Staffing: Concept, Scope of Staffing, Manpower Planning, Selection & Training, Performance Appraisal. Directing: Concept, Importance. Motivation: Concept, Importance, Maslow’s Need Hierarchy theory, Leadership: Concept, Characteristics of

Leadership, and Leadership styles. Communication: Types, Process, Channels and Barriers of Communication. Coordinating: Definition, Characteristics, Principles and Techniques of Coordination, Concept of Managerial Effectiveness. Controlling: Concept, Importance, Process of Controlling, Management Control Techniques, Effective Control Systems.

References:

1. Stephen P. Robbins, Mary Coulter, David De Cenzo: *Fundamentals of Management*, Ninth Edition, Pearson Education India, 2016.
2. Mitra, J.K.: *Principles of Management*, Oxford Publication, 2017.
3. Koontz, H.: *Essentials of Management*, Tata McGraw Hill Education, 2020.
4. Bhushan, Y.K.: *Fundamentals of Business Organization and Management,* Sultan Chand & Sons,9th Edition, 2018.
5. Tripathi P. Chandra: *Principles of Management*, Tata McGraw-Hill Education, Re-print - 2024.

MCE2203 SENSORS AND ACTUATORS [3 1 0 4]

Introduction to Sensors and Actuators: Role of sensors and actuators in engineering systems. Classification and performance characteristics. Static response of sensors. Sensors – Principles and Applications: Sensors for physical processes and industrial application. Signal Conditioning and Data Acquisition: Amplification, filtering, modulation. Analog-to-digital (ADC) and digital-to-analog (DAC) conversion. Actuators – Principles and Types: Electrical actuators: DC motors, stepper motors, servo motors, BLDC. Hydraulic and pneumatic actuators: principles, characteristics, applications. Integration of Sensors and Actuators: Case studies.

References:

1. D. Patranabis, *Sensors and Transducers*. New Delhi, India: PHI Learning Pvt. Ltd., 2020.
2. J. G. Webster, Ed., *Measurement, Instrumentation, and Sensors Handbook*. Boca Raton, FL, USA: CRC Press, 2021.
3. C. W. de Silva, *Sensors and Actuators: Control System Instrumentation*. Boca Raton, FL, USA: CRC Press, 2015.
4. J. Fraden, *Handbook of Modern Sensors: Physics, Designs, and Applications,* Re-Print - Cham, Switzerland: Springer, 2016.

MCE2240 DIGITAL SYSTEM DESIGN [3 0 0 3]

Number system, Boolean algebra, Logic gates, Concept of K-Maps reduction, Design of combinational circuits: Adder, Subtractor, Encoder, Decoder, Multiplexer, Demultiplexer. Design sequential circuits by using memory elements like latches, flip-flops, Counters, Registers, Synchronous Counters, Asynchronous counters, Logic families, Analysis and Design of Finite State Machines, Sequence Generator and Sequence Detector-Lock out condition, Design examples, Basics of FPGA Architecture.

References:

1. M. M. Mano and M. D. Ciletti, *Digital Design*, 6th ed. Boston, MA, USA: Pearson, 2018.
2. A. A. Kumar, *Switching Theory and Logic Design*, 3rd ed. New Delhi, India: PHI Learning, 2016.
3. D. J. Comer, *Digital Logic and State Machine Design*, 3rd ed. Fort Worth, TX, USA: Saunders College Publishing (Oxford Series in ECE), 2021.
4. S. Palnitkar, *Verilog HDL: A Guide to Digital Design and Synthesis*, 2nd ed. Boston, MA, USA: Pearson, 2023.

MCE2241 IOT SYSTEM [3 0 0 3]

Introduction to M2M communication and IoT, industrial structure for IoT, IoT system architecture, reference model, deployment and operational view, physical devices and endpoints, Communication, and

networking protocols-MQTT, CoAP, Web Sockets, HTTP and AMQP protocols, IoT enabling technologies-RFID, WSN, SCADA etc., Future internet design for various IoT use cases such as smart cities, smart environments, smart homes, smart health etc.

References:

1. J. Höller, V. Tsiatsis, C. Mulligan, S. Karnouskos, S. Avesand, and D. Boyle, *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, 1st ed. Oxford, U.K.: Elsevier, 2020.
2. A. Bahga and V. Madisetti, *Internet of Things: A Hands-On Approach*. Hyderabad, India: Universities Press–East-West Press, 2019.
3. H. Geng, Ed., *Internet of Things and Data Analytics Handbook*, 1st ed. Hoboken, NJ, USA: Wiley, 2016.
4. Y. Patil, *Azure IoT Development Cookbook*, 1st ed. Birmingham, U.K.: Packt Publishing, 2021.

MCE0001 FUNDAMENTAL OF ROBOTICS [3 0 0 3]

Introduction- Basics of robotics, Laws of Robotics, Different kinds of Robots, Degrees of freedom (DOF), types of movements, vertical, radial, and rotational, roll, pitch and yaw, Wok envelope, robot configuration space. Sensors- sensor classification, applications of sensors, need of sensors, selections of sensors. Actuators- transmission and drives systems, Hydraulic, Pneumatic and Electric drive systems, classification of end effectors. Automation- Types of automation, Levels of Automation, need of automation, AI- Introduction to artificial intelligence, AI techniques, Need and application of AI. Robot programming – Deferent methods of robot programming, Robot applications, future of robots.

References:

1. J. J. Craig, *Introduction to Robotics – Mechanics and Control*, 4th ed. Boston, MA, USA: Pearson, 2022.
2. S. R. Deb, *Robotics Technology and Flexible Automation*, 2nd ed. New Delhi, India: McGraw-Hill Education India, 2021.
3. M. Vidyasagar and M. W. Spong, *Robot Dynamics and Control*. New York, NY, USA: Wiley, 2020.

XXXX TECHNICAL REPORT WRITING [2 0 0 2]

The essentials of planning and organizing technical reports; understanding report structure including title page, abstract, table of contents, introduction, methods, results, discussion, conclusions, references, and appendices; principles of clear, concise, and objective technical writing; effective use of diagrams, tables, graphs, and data; proper referencing and citation practices; editing and proofreading strategies; and tailoring reports for specific technical audiences such as industry and academia, Latex – Overleaf, TeX Live / MiKTeX, Reference & Citation Management, Google Scholar Search, Scopus Search, Jupyter Notebook.

References:

1. R. Barrass, *Scientists must write: A guide to better writing for scientists, engineers and students,* Routledge, 2005.
2. H. Hering, H. Heike et al., *How to write technical reports*, Berlin, Germany: Springer Berlin Heidelberg, 2019.

MCE2232 SENSORS AND ACTUATORS LAB [0 0 2 1]

Study of Resistive, Capacitive, and Inductive Sensors, Temperature Measurement, Displacement & Proximity Measurement, Pressure and Force Measurement, Interfacing Sensors with Arduino/Microcontroller, Speed and Position Control of DC Motor/Stepper Motor, Servo Motor Control, Hydraulic/Pneumatic Actuator Demonstration, Demonstration of Hydraulic and Pneumatic actuators, Closed-loop Temperature Control System, Mini Project.

References:

1. C. W. de Silva, *Sensors and Actuators: Control System Instrumentation*. Boca Raton, FL, USA: CRC Press, 2015.
2. D. Patranabis, *Sensors and Transducers*, 3rd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2020.
3. J. Fraden, *Handbook of Modern Sensors: Physics, Designs, and Applications*, 5th ed. Cham, Switzerland: Springer, 2016.
4. *Datasheets and Application Notes of Sensors and Actuators Used in the Laboratory*. Various Manufacturers, 2025.

MCE2231 INTEGRATED ELECTRONICS LAB [0 0 2 1]

Analog circuit designs using 741 IC, linear applications of Op-amps: design of rectifiers, DACs and ADCs, filters, multivibrators & Schmitt trigger using 555 IC, regulators. Digital circuit designs- combinational circuit's, implementation of Boolean functions and arithmetic circuits, multiplexers, encoders, decoders, code converters, design of sequential circuits- ripple counters, shift registers and ring counters, synchronous counters, sequence detectors.

References:

1. S. Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, 4th ed. New York, NY, USA: McGraw-Hill, 2015.
2. M. M. Mano and M. D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog*, 6th ed. Boston, MA, USA: Pearson, 2018.

MCE2271 PROJECT-BASED LEARNING-1 [0 0 0 3]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

References:

1. S. Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, 4th ed. New York, NY, USA: McGraw-Hill Education, 2015.
2. M. M. Mano and M. D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog*, 6th ed. Boston, MA, USA: Pearson, 2018.

FIFTH SEMESTER

MCE3101 DESIGN OF MACHINE ELEMENTS [3 0 0 3]

Basic Concepts: Fundamentals of Mechanical Design: The Design Process, Economics of Design, Reliability, Safety and Product Liability, Codes and Standards, Types of Materials, Stress-Strain Response, Types of Loads and Stresses, Failure Modes, Factor of Safety, Strength Design. Static And Variable Stress Analysis: Static Strength, Failure Theories, Stress Concentration, Fatigue Strength, Stress-Life (S-N) Diagram, High Cycle Fatigue, Endurance Limit Modifying Factors, Effect of Mean Stress, Fluctuating Stresses, and Stresses due to Combined Loading. Design For Static and Fatigue Load, Springs: Helical Spring: Compression Springs of Round/Square/Rectangular Wires, Spring Materials, Stress and Deflection of Spring Subjected to Steady, Fluctuating and Impact Loads, Spring Surge and Buckling, Concentric Springs. Design of Spur Gears, Design of Shaft.

References:

1. J. K. Nisbett, R. G. Budynas, and C. R. Mischke, *Shigley's Mechanical Engineering Design*, 2024 Release. New York, NY, USA: McGraw-Hill LLC, 2024.
2. R. L. Norton, *Machine Design: An Integrated Approach*, 6th ed. Boston, MA, USA: Pearson, 2020.
3. U. C. Jindal, *Machine Design*, 2nd ed. New Delhi, India: Pearson Education India, 2024.
4. V. B. Bhandari, *Design of Machine Elements*, 5th ed. New Delhi, India: McGraw-Hill Education, 2021.

MCE3102 ROBOTICS [3 0 0 3]

Introduction of robots and its types, degrees of Freedom of robot, Robot Configuration, Specification of a robot; Manipulator Kinematics: Homogeneous Transformations, Forward and Inverse Kinematics, Differential motions and velocity: Differential motions of joints and robot, Jacobians, Dynamics: Euler-Lagrange Equations of Motion, Properties of Robot Dynamics, Robot statics, Trajectory planning: Joint space trajectory planning, Cartesian space trajectory planning. Kinematics of wheeled mobile robots.

References:

1. Y. Kozyrev, *Industrial Robots Handbook*, 2nd ed. Moscow, Russia: Mir Publishers, 2022.
2. S. B. Niku, *Introduction to Robotics: Analysis, Control, Applications*, 3rd ed. Hoboken, NJ, USA: Wiley, 2020.
3. S. G. Tzafestas, *Introduction to Mobile Robot Control*, 1st ed. Oxford, U.K.: Elsevier, 2013.
4. M. W. Spong and M. Vidyasagar, *Robot Dynamics and Control*. New York, NY, USA: Wiley, 2021.
5. Y. Koren, *Robotics for Engineers*. New York, NY, USA: McGraw-Hill, 2024.

MCE3105 MOBILE ROBOTS [3 1 0 4]

Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability; Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, Control theory - Control design basics, Cruise-Controllers, Performance Objectives. Simple robot - State space model, Linearization, LTI system, stability. PID control, basic control algorithms, Sensors for mobile robots - Classification, performance, uncertainty in sensors, wheel sensor, heading sensor, accelerometers, inertial measurement, motion sensor, range sensors.

References:

1. R. Siegwart, I. R. Nourbakhsh, and D. Scaramuzza, *Introduction to Autonomous Mobile Robots*, 2nd ed. Cambridge, MA, USA: MIT Press, 2021.
2. P. Corke, *Robotics, Vision, and Control: Fundamental Algorithms in MATLAB*, 3rd ed. Cham, Switzerland: Springer, 2023.
3. S. M. LaValle, *Planning Algorithms*. Cambridge, U.K.: Cambridge Univ. Press, 2020.
4. S. Thrun, W. Burgard, and D. Fox, *Probabilistic Robotics*. Cambridge, MA, USA: MIT Press, 2025.
5. E. R. Melgar and C. C. Diez, *Arduino and Kinect Projects: Design, Build, Blow Their Minds*. New York, NY, USA: Apress, 2022.
6. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. Kavraki, and S. Thrun, *Principles of Robot Motion: Theory, Algorithms, and Implementations*. Cambridge, MA, USA: MIT Press, 2025.

MCE3106 MODERN CONTROL THEORY [3 0 0 3]

Analysis and design of linear systems, Feedback of control systems, Physical systems, Time and frequency domain analysis, System Compensation: Using elementary lag, lead and lead- lag compensating networks, Mathematical Preliminaries and State Variable Analysis, Linear dynamical systems, Autonomous system, Controllability and Observability, feedback controllers, introduction to non-linear systems, stability analysis, Optimal and Adaptive Control.

References:

1. K. Ogata, *Modern Control Engineering*, 3rd ed. Englewood Cliffs, NJ, USA: Prentice Hall, 2025.
2. F. L. Lewis, *Applied Optimal Control and Estimation*. Englewood Cliffs, NJ, USA: Prentice Hall, 2024.
3. B. Friedland, *Control System Design*. New York, NY, USA: McGraw-Hill, 2000.

MCE3140 FINITE ELEMENT METHODS [3 0 0 3]

Introduction to FEM: Overview of FEM, basic steps, and applications, Mathematical Foundations: Strong and weak formulations, variational methods, and element types, 1D Finite Element Analysis: Stiffness matrices, boundary conditions, applications to trusses and beams, 2D Finite Element Analysis: Shape functions, plane stress/strain, applications in structural analysis and heat conduction, 3D Finite Element Analysis: 3D elements, stiffness matrices, applications in structural analysis. Software Applications & Case Studies: FEM software tools, hands-on projects, and case studies in engineering.

References:

1. J. N. Reddy, *An Introduction to the Finite Element Method*, 4th ed. New York, NY, USA: McGraw-Hill, 2018.
2. S. S. Rao, *The Finite Element Method in Engineering*, 6th ed. Oxford, U.K.: Butterworth-Heinemann, 2019.

3. O. C. Zienkiewicz, R. L. Taylor, and J. Z. Zhu, *The Finite Element Method: Its Basis and Fundamentals*, 8th ed. Oxford, U.K.: Butterworth-Heinemann, 2023.
4. R. D. Cook, D. S. Malkus, M. E. Plesha, and R. J. Witt, *Concepts and Applications of Finite Element Analysis*, 4th ed. Hoboken, NJ, USA: Wiley, 2021.
5. K. J. Bathe, *Finite Element Procedures*, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2024.
6. S. Moaveni, *Finite Element Analysis: Theory and Application with ANSYS*, 5th ed. Boston, MA, USA: Pearson, 2020.

MCE3141 SIGNALS AND SYSTEMS [3 0 0 3]

Introduction: Definitions, Overview of specific systems, Classification of signals, Basic operations on signals, Elementary signals and functions, Systems viewed as interconnections of operations, properties of systems. Time domain representations for linear time-invariant systems: Introduction, Convolution: Impulse response representation for LTI systems, properties of the impulse response representation for LTI systems, Differential and difference equation representations for LTI systems, S-domain transformation using Laplace transform, Fourier representation for signals: The discrete-time Fourier series, continuous-time periodic signals: Discrete-time non-periodic signals: The discrete-time Fourier transform, Z-Transform, The Fourier transform, properties of Fourier representations, Fast Fourier transform. Signal processing in MATLAB.

References:

1. R. P. Ramesh Babu and R. Anandanatarajan, *Signals & Systems*, 5th rev. ed. Chennai, India: Vijay Nicole Publication, 2022.
2. S. Haykin and B. V. Veen, *Signals and Systems*, 2nd ed. Hoboken, NJ, USA: Wiley, 2020.
3. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 5th ed. New York, NY, USA: Pearson, 2021.

MCE0002 AUTOMATION IN INDUSTRY [3 0 0 3]

Introduction to Industrial Automation, Intelligent Systems, Hydraulic Actuators for Industrial Applications, Pneumatic Actuators for Industrial Applications, Actuator Automation, Flow control valves, Electric Drives, Sensors and Vision used for Industrial automation, Trajectory planning, Automation Algorithm, Hydraulic and electrohydraulic system in Industries, Programming and flow control for automation.

References:

1. G. S. Hegde, *A Textbook on Industrial Robotics*, 2nd ed. New Delhi, India: University Science Press, 2024.
2. S. Manesis and G. Nikolakopoulos, *Introduction to Industrial Automation*, 1st ed. Boca Raton, FL, USA: CRC Press, 2018.
3. M. P. Groover, M. Weiss, R. N. Nagel, N. Odrey, and A. Dutta, *Industrial Robotics: Technology, Programming and Applications*, 2nd ed. New York, NY, USA: McGraw-Hill Education, 2023.
4. K. M. Lynch and F. C. Park, *Modern Robotics*, 1st ed. Cambridge, U.K.: Cambridge University Press, 2017.
5. G. S. Hegde, *A Textbook on Industrial Robotics*, Indian ed. New Delhi, India: Laxmi Publications, 2025.

MCE3130 DESIGN AND MODELLING LAB [0 0 2 1]

Introduction of 2D model design and 3D CAD parametric design; CREO parametric design: Sketch, Part modelling, Surface modelling, Dimensions and annotation; Assembly; Advanced assembly; Multi-view drawing and reading; Animation; Mechanical part design; Robotic arm part design.

References:

1. I. Zeid, *CAD/CAM Theory and Practice*, 2nd ed. New York, NY, USA: McGraw-Hill Education, 2023.

2. R. H. Shih, *Parametric Modeling with Creo Parametric 11.0: An Introduction to Creo Parametric 11.0*, 1st ed. Mission, KS, USA: SDC Publications, 2024.

MCE3133 ROBOTICS LAB [0 0 2 1]

Forward and inverse kinematics of a Robot, velocity analysis, Mobile robot, Dynamics of Robot Manipulators, Control of Robot Manipulators: PID control, Adaptive Control, Robot Path-Planning.

References:

1. Y. Kozyrev, *Industrial Robots Handbook*, 2nd ed. Moscow, Russia: Mir Publishers, 2024.
2. S. B. Niku, *Introduction to Robotics: Analysis, Control, Applications*, 3rd ed. Hoboken, NJ, USA: Wiley, 2020.
3. S. G. Tzafestas, *Introduction to Mobile Robot Control*, 1st ed. Amsterdam, Netherlands: Elsevier, 2023.
4. M. W. Spong and M. Vidyasagar, *Robot Dynamics and Control*. New York, NY, USA: Wiley, 2022.
5. Y. Koren, *Robotics for Engineers*. New York, NY, USA: McGraw-Hill, 2023.
6. J. J. Craig, *Introduction to Robotics: Mechanics and Control*, 4th ed. Hoboken, NJ, USA: Pearson, 2021.

MCE3171 PROJECT BASED LEARNING - 2 [0 0 0 3]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

References:

1. S. Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, 4th ed. New York, NY, USA: McGraw-Hill Education, 2019.
2. M. M. Mano and M. D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog*, 6th ed. Boston, MA, USA: Pearson, 2018.

MCE3190 ROBOT TRAJECTORY PLANNING [3 0 0 3]

Introduction to Trajectory Planning: Difference between path planning and trajectory planning. Applications in industrial and service robotics. Constraints in robot trajectory generation. Mathematical Representation of Trajectories. B-splines and Bezier curves for smooth trajectories. Time Parameterization and Motion Profiles: Uniform and trapezoidal velocity profiles. Synchronization of multi-joint trajectories. Sampling-Based Planning Algorithms: Probabilistic Roadmaps (PRM). RRT and RRT*. Applications in high-DOF robotic systems. Search-Based and Optimization Approaches: Graph search methods. AI and learning based approaches. Neural network-based trajectory generation. Applications and Case Studies.

References:

1. B. Siciliano, L. Sciavicco, L. Villani, and G. Oriolo, *Robotics: Modelling, Planning and Control*. London, U.K.: Springer, 2021.

2. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, *Principles of Robot Motion: Theory, Algorithms, and Implementations*. Cambridge, MA, USA: MIT Press, 2025.
3. S. M. LaValle, *Planning Algorithms*. Cambridge, U.K.: Cambridge Univ. Press, 2022.
4. B. Siciliano and O. Khatib, Eds., *Springer Handbook of Robotics*, 2nd ed. Cham, Switzerland: Springer, 2016.

MCE3180 MECHATRONICS SYSTEM DESIGN [3 0 0 3]

Introduction to Mechatronics: Definition, scope, Evolution of mechatronics and applications in industry. Mechatronic design approach. Mechanical components and system modeling. Electrical and electronic elements. Integration of sensors, actuators, and signal conditioning. Sensors and Actuators in Mechatronics. Control Systems for Mechatronics: Classical control. Digital and adaptive control approaches. Real-time control and feedback systems. Embedded programming. System Modeling and Simulation: Mathematical modeling of mechatronic systems. Simulation tools: MATLAB/Simulink and ROS. Case Studies and Advanced Topics.

References:

1. W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, 7th ed. Harlow, U.K.: Pearson, 2021.
2. D. Shetty and R. A. Kolk, *Mechatronics System Design*, 3rd ed. Stamford, CT, USA: Cengage Learning, 2020.
3. R. H. Bishop, Ed., *The Mechatronics Handbook*, 2nd ed. Boca Raton, FL, USA: CRC Press, 2007.
4. D. G. Alciatore and M. B. Histand, *Introduction to Mechatronics and Measurement Systems*, 6th ed. New York, NY, USA: McGraw-Hill, 2021.

MCE3281/MCE3290 ROBOTICS AND ITS CONTROL [3 0 0 3]

Introduction of control system, Classification of control Systems, Open loop and Closed loop Control System, Feedback Control System. Mathematical Preliminaries, Controllers – Proportional (P), Integral (I) and Derivative (D) Blocks, PID controller design, Case Study of PID Controller. Standard Inputs, Free and Forced Response, Transfer Function, Poles and Zeros. Effect of Poles. Effect of Zeros, Closed Loop Transfer Function, First Order Systems. Robotics- Robot Control System Components; Mobile Robot Control- Control strategies for mobile robots.

References:

1. K. Ogata, *Modern Control Engineering*, 5th ed. Harlow, U.K.: Prentice Hall, 2024.
2. N. S. Nise, *Control Systems Engineering*, 7th ed. Singapore: Wiley, 2017.
3. B. C. Kuo and F. Golnaraghi, *Automatic Control Systems*, 9th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2014.
4. M. W. Spong, S. Hutchinson, and M. Vidyasagar, *Robot Modeling and Control*, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2020.
5. K. M. Lynch and F. C. Park, *Modern Robotics: Mechanics, Planning, and Control*. Cambridge, U.K.: Cambridge Univ. Press, 2017.

SIXTH SEMESTER

MCE3201 DRIVES AND AUTOMATION [3 1 0 4]

Introduction to power switches and power converters, components of electric drives, factors affecting choice of drives, fundamental torque equation, speed-torque conventions, multi-quadrant operation of electric drives, speed control of DC motors, induction motors, Servo motors, BLDC motors and Stepper motors, electric braking, Automation Hierarchy and basic component of automation system, introduction to Sequence Control, PLCs and Relay Ladder Logic.

References:

1. G. K. Dubey, *Fundamentals of Electrical Drives*, 2nd ed. New Delhi, India: Narosa Publishing House, 2020, reprint ed. 2022.
2. I. J. Nagrath and D. P. Kothari, *Electric Machines*, 5th ed. New Delhi, India: Tata McGraw-Hill, 2017.
3. J. W. Webb and R. A. Reis, *Programmable Logic Controllers: Principles and Applications*, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2015.
4. K. Ogata, *Modern Control Engineering*, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2021.
5. A. Parr, *Hydraulics and Pneumatics: A Technician's and Engineer's Guide*, 3rd ed. Oxford, U.K.: Elsevier Butterworth-Heinemann, 2013.

MCE3242 ADDITIVE MANUFACTURING [3 0 0 3]

AM importance, generic process, stereolithography/3D printing, rapid prototyping, benefits, AM vs CNC, reverse engineering. Eight steps of AM, machine variations, metal systems, equipment maintenance, material handling, design for AM, applications. AM Processes: Photopolymerization Powder Bed Fusion, Extrusion-based Systems, Printing Processes (evolution in AM), Sheet Lamination: LOM, UC, gluing, thermal bonding, applications, Beam Deposition & Direct Write. Guidelines, methods, challenges, example system, production planning/control. Support removal, surface finishing, pattern prep, property enhancement (thermal & non-thermal).

References:

1. C. K. Chua and K. F. Leong, *3D Printing and Additive Manufacturing: Principles and Applications*, 5th ed. Singapore: World Scientific Publishing Co., 2016.
2. A. K. Kamrani and E. Abouel Nasr, *Rapid Prototyping: Theory and Practice*, 1st ed. New York, NY, USA: Springer, 2024.
3. D. T. Pham and S. S. Dimov, *Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling*, 1st ed. London, U.K.: Springer, 2021.
4. R. Noorani, *Rapid Prototyping: Principles and Applications in Manufacturing*, 1st ed. Hoboken, NJ, USA: Wiley, 2022.
5. H. Prasad and A. V. Suresh, *Additive Manufacturing Technology*, 1st ed. Boston, MA, USA: Cengage, 2019.

MCE3243 CYBER PHYSICAL SYSTEM [3 0 0 3]

Cyber-Physical Systems (CPS) in the real world, basics of cyber physical system, components of cyber physical system, real time sensing and communication for CPS, basics of wireless sensor network, control of CPS: dynamical system modelling, stability, controller design, event triggered control, distributed control, control challenges; basics of networked control system, security of cyber physical systems, Attack Detection and Mitigation in CPS, case studies.

References:

1. E. A. Lee and S. A. Seshia, *Introduction to Embedded Systems: A Cyber-Physical Systems Approach*, 2nd ed. Cambridge, MA, USA: MIT Press, 2017.
2. R. Alur, *Principles of Cyber-Physical Systems*, 1st ed. Cambridge, MA, USA: MIT Press, 2015.
3. M. Wolf, *High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing*, 2nd ed. San Francisco, CA, USA: Morgan Kaufmann, 2014.
4. H. H. Song, D. B. Rawat, S. Jeschke, and C. Brecher, Eds., *Cyber-Physical Systems: Foundations, Principles and Applications*, 1st ed. Cambridge, MA, USA: Academic Press, 2016.

MCE3252 COLLABORATIVE ROBOTS [3 0 0 3]

Introduction, Types of Robots, Industrial Robot, Service Robot, Cobots, Custom Robots, Flexible Robots, Industrial robots, Remote programming concept, Camera vision Systems, Different Sensors and actuators, Sensor data Integration, Sensor Data Fusion, Data Acquisitions, Simulations, Environment, Plant models, Payload, Cobot specifications - Shape, Size, Sensitivity, Sophistication, Challenges for testing with cobots, Autonomy Type, Autonomy in Cobot, Scope of cobots, Performance based applications, User based applications, Other Industrial applications, System testing, Assisted testing.

References:

1. P. Matthews and S. Greenspan, *Automation and Collaborative Robotics: A Guide to the Future of Work*, 1st ed. New York, NY, USA: Apress, 2020.
2. C. Urdiales, *Collaborative Assistive Robot for Mobility Enhancement (CARMEN)*, 1st ed. Berlin, Germany: Springer, 2022.
3. T. R. Kurfess, Ed., *Robotics and Automation Handbook*, 1st ed. Boca Raton, FL, USA: CRC Press, 2018.

MCE3253 INTELLIGENT SYSTEMS [3 0 0 3]

Intelligent agent, structure and architecture of agents, basic elements of fuzzy systems, fuzzification, Fuzzy inference, Artificial Neural Networks (ANN) biological analogues, ANN training algorithms, supervised learning, gradient methods, reinforcement learning, unsupervised learning, deep Learning,

applications: adaptive control, self-tuning PID controllers, cooperative Intelligence, characteristics of cooperative intelligence, particle swarm optimization, ant colony optimization, multi-agent systems.

References:

1. V. C. S. S. and A. Hareendran, *Artificial Intelligence and Machine Learning*, 2nd ed. New Delhi, India: PHI Learning, 2020.
2. T. J. Ross, *Fuzzy Logic with Engineering Applications*, 4th ed. Hoboken, NJ, USA: Wiley, 2016.
3. C. M. Bishop, *Pattern Recognition and Machine Learning*, reprint ed. Berlin, Germany: Springer, 2022.
4. A. Artasanchez and P. Joshi, *Artificial Intelligence with Python*, 2nd ed. Birmingham, U.K.: Packt Publishing, 2020.

MCE3204 FLUID MECHANICS [3 1 0 4]

Fundamentals: Definition and properties of fluids, intensity of pressure, variation of pressure in a static fluid, Absolute, Gauge, Atmospheric and Vacuum pressure Manometers, Fluid statics: Hydro static forces and center of Pressure on vertical and inclined plane surfaces, Buoyancy, center of Buoyancy, Metacentre and Meta-centric height, Analytical method for determination of Meta-centric height, Stability of floating and sub-merged bodies, Kinematics and Dynamics of fluid flow : Types of fluid flow, continuity equation, one dimensional Euler's equation of motion, Bernoulli's energy equation, Fluid flow measurements: Pitot tube, orifice meter and venture meter, Fluid flow in pipes: Darcy weisbach equation. Losses in pipes - Minor and major losses, Dimensional analysis and Similitude: Methods of dimensional analysis, similitude.

References:

1. F. M. White and H. Xue, *Fluid Mechanics*, 9th ed. New York, NY, USA: McGraw-Hill Education, 2020.
2. Y. A. Çengel and J. M. Cimbala, *Fluid Mechanics: Fundamentals and Applications*, 5th ed. New York, NY, USA: McGraw-Hill Education, 2024.
3. V. L. Streeter, E. B. Wylie, and K. W. Suomi, *Fluid Mechanics*, 9th ed. New York, NY, USA: McGraw-Hill, 2022.

MCE3263 MEMS AND NEMS [3 0 0 3]

Introduction to MEMS and NEMS and Microsystems: Evolution of micro and nano fabrication, microelectronics, application in the automotive and other industries; Materials for MEMS and NEMS: Substrates and wafers, Packaging materials; Micro and Nano fabrication Processes: Lithography processes, Ion implantation, Diffusion, Oxidation, Chemical and Physical fabrication process, Deposition by Epitaxy, Etching, Surface micromachining. Working principles of Microsystems; Micro and Nano sensors ; Micro and Nano actuators; Scaling laws in miniaturization: Scaling in geometry, Scaling in rigid body dynamics, Scaling in electrostatic, electromagnetic forces, Scaling in electricity, Scaling in heat transfer and fluid mechanics.

References:

1. T.-R. Hsu, *MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering*, 2nd ed. Hoboken, NJ, USA: Wiley, 2020.
2. C. Liu, *Foundations of MEMS*, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2022.
3. M. J. Madou, *Fundamentals of Microfabrication and Nanotechnology*, 3rd ed., 3-volume set. Boca Raton, FL, USA: CRC Press, 2021.
4. W. Menz, J. Mohr, and O. Paul, *Microsystem Technology*, revised ed. Weinheim, Germany: Wiley-VCH, 2021.

MCE3264 ARTIFICIAL INTELLIGENCE [3 0 0 3]

Introduction to AI and intelligent agents. Uninformed search, Heuristic search, stochastic search, adversarial search, game playing. Machine Learning: basic concepts, linear models, perceptrons, neural networks, naive Bayes, Decision trees, ensemble, logistic regression, and unsupervised learning. Constraint satisfaction problems, Markov decision processes, reinforcement learning. Logical agents, propositional logic and first order logic, planning, partial order planning, Bayesian Networks, natural language processing, AI applications.

References:

1. S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 4th ed. Boston, MA, USA: Pearson, 2020.
2. K. Knight, E. Rich, and B. S. Nair, *Artificial Intelligence*, 4th rev. ed. New York, NY, USA: McGraw-Hill Education, 2024.
3. D. W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, latest ed., circa 2021.
4. G. F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, 8th ed. Boston, MA, USA: Pearson, 2021.

MCE0003 INTRODUCTION TO BUILDING AUTOMATION [3 0 0 3]

Introduction to Building Automation- Overview of Building Automation, History and evolution of BAS, Importance and benefits of BAS, Components of a BAS, Fundamentals of Control Systems- open-loop and closed-loop, Sensors and actuators; Energy Management Systems (EMS)- Overview of energy management, Role of BAS in energy conservation, Monitoring and controlling energy usage; Building Automation Software; Smart Buildings and IoT Integration- Introduction to smart buildings, Internet of Things (IoT) in building automation, Future trends in building automation.

References:

1. B. L. Capehart and L. C. Capehart, *Web-Based Enterprise Energy and Building Automation Systems: Design and Installation*, 1st ed. River Falls, WI, USA: River Publishers, 2020.
2. H. Merz, T. Hansemann, and C. Hübner, *Building Automation: Communication Systems with EIB/KNX, LON, and BACnet*, 1st ed. Berlin, Germany: MBS Mess- und Bussysteme, 2018.
3. J. M. Sinopoli, *Smart Building Systems for Architects, Owners and Builders*, 1st ed. Oxford, U.K.: Butterworth-Heinemann, 2009.
4. R. A. Panke, *Energy Management Systems and Direct Digital Control*, 1st ed. Oxford, U.K.: Butterworth-Heinemann, 2022.

MCE3231 DRIVES AND AUTOMATION LAB [0 0 2 1]

Power converters and their operational characteristics, Control of Drives: DC motors, induction motors, BLDC motor, stepper motor, servo motor, PLC integration with pneumatic and hydraulic system and their control, implementation of PID control using PLC.

References:

1. G. K. Dubey, *Fundamentals of Electrical Drives*, 2nd ed. New Delhi, India: Narosa Publishing House, 2022.
2. I. J. Nagrath and D. P. Kothari, *Electric Machines*, 5th ed. New Delhi, India: Tata McGraw-Hill, 2017.
3. M. H. Rashid, *Power Electronics: Circuits, Devices & Applications*, 4th ed. Boston, MA, USA: Pearson, 2014.
4. Bosch Rexroth AG, *Project Manual Industrial Hydraulics*, document RE 00845/04.07. Stuttgart, Germany: Bosch Rexroth AG, latest revision, 2020.
5. S. R. Majumdar, *Pneumatic Systems – Principles and Maintenance*, New Delhi, India: McGraw-Hill Education, 2019.

MCE3233 PNEUMATICS AND HYDRAULICS LAB [0 0 4 2]

Operations of various valves like directional control valves, flow control, valves, pressure control valves and switches like pressure switches, proximity switches. Operations of timers and counters. Rigging of manual pneumatic and electro-pneumatic circuits using above valves and switches. Working principles of hydraulic pumps, hydraulic motors, throttle valves, direction control valves. Manual and electro-hydraulic circuits using above components. Manual and electro-hydraulic circuits using above components.

References:

1. E. Anthony, *Fluid Power with Applications.* New York, NY, USA: Pearson Education, 2023.
2. S. R. Majumdar, *Pneumatic Systems: Principles and Maintenance.* New Delhi, India: Tata McGraw-Hill, 2020.
3. E. A. Parr, *Hydraulics and Pneumatics: A Technician's and Engineer's Guide*, 3rd ed. Oxford, U.K.: Butterworth-Heinemann, 2011.
4. J. Parambath, *Design of Industrial Hydraulic Systems: In the SI Units*. Independently published, 2020.

SEVENTH SEMESTER

MCE4143 MACHINE VISION [3 0 0 3]

Image Acquisition and Analysis: Vision system components, Image acquisition and analysis, Image digitization, Image enhancement, restoration, Segmentation, Morphological Operations, image representation and analysis, color image processing. 3D Vision: Camera and optics, Perspective Projection Geometry Rotation and translation matrix, Pinhole camera model, Calibration methods, Intrinsic and Extrinsic Camera Parameters, Stereovision, Stereo correspondence Algorithms, Epipolar Geometry, Essential and fundamental matrix, 3D Reconstruction. Motion Estimation and Tracking: Optical Flow estimation, Object tracking with Kalman filtering. Basic idea of localization employing passive markers. Case Studies/Application: Basic color detection, Face recognition, Vehicle tracking, applications using computer vision toolbox and image processing toolbox of MATLAB.

References:

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 4th ed. Boston, MA, USA: Pearson, 2018.
2. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis, and Machine Vision*, 4th ed. Boston, MA, USA: Cengage Learning, 2014.
3. B. Cyganek and J. P. Siebert, *An Introduction to 3D Computer Vision Techniques and Algorithms*, 2nd ed. Hoboken, NJ, USA: Wiley, 2019.
4. D. A. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, 2nd ed. Boston, MA, USA: Pearson, 2015.
5. E. R. Davies, *Machine Vision: Theory, Algorithms, Practicalities*, 5th ed. London, U.K.: Academic Press, 2012.

MCE4144 PRODUCTION AND OPERATION MANAGEMENT [3 0 0 3]

Operations Strategy in a global economy, Operations Management and Productivity, Types and Characteristics of Manufacturing and Service Systems, Product Design. Introduction to Forecasting, Introduction to Time-series forecasts, Extrapolative methods Causal Methods of forecasting, Qualitative Methods of Forecasting, Introduction to Inventory Management, Various costs involved in inventory management, Models of Inventory Management, Various variations of EOQ, Inventory Models with Uncertain Demand, Inventory Models with Uncertain Demand, Miscellaneous Systems and Issues, Inventory Control and Supply Chain Management, Nature of Quality, Evolution of Quality Management, Modern Quality Management, Total Quality Management, Statistical Concepts in Quality Control, Acceptance Sampling, 7 QC Tools, Service Facility Layout, JIT Manufacturing, Lean Manufacturing, Kanban Production System, Case Discussions on JIT and Lean Philosophy. Maintenance Management, Total Productive Maintenance, Introduction to Project Management, PERT and CPM

References:

1. W. J. Stevenson, *Operations Management*, 14th ed. New York, NY, USA: McGraw-Hill Education, 2021.
2. E. S. Buffa and R. K. Sarin, *Modern Production/Operations Management*, 8th ed. Hoboken, NJ, USA: Wiley, 2020.
3. R. B. Chase, F. R. Jacobs, and N. J. Aquilano, *Operations Management for Competitive Advantage*, 11th ed. New York, NY, USA: McGraw-Hill Irwin, circa 2018.
4. N. Gaither and G. Frazier, *Operations Management*, 9th ed. Boston, MA, USA: Cengage Learning, 2025.

MCE4153 INDUSTRIAL IOT [3 0 0 3]

Introduction to M2M communication and IoT, An emerging industrial structure for IoT, IoT system architecture, IoT reference model, IoT deployment and operational view, IoT physical devices and endpoints, Communication and networking protocols-MQTT and AMQP protocols, IoT enabling technologies-RFID, WSN,SCADA etc., Analytics for the IoT, Applying the geospatial analytics to IoT data, Real world design constraint, Technical design constraint, Future internet design for various IoT use cases such as smart cities, smart environments, smart homes, smart health etc.

References:

1. J. Holler, V. Tsiatsis, C. Mulligan, S. Karnouskos, S. Avesand, and D. Boyle, *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, 1st ed. Amsterdam, Netherlands: Elsevier, 2014.
2. A. Bahga and V. Madisetti, *Internet of Things: A Hands-On Approach*, 1st ed. Hyderabad, India: Orient Blackswan, 2015.
3. H. Geng, Ed., *Internet of Things and Data Analytics Handbook*, 1st ed. Hoboken, NJ, USA: Wiley, 2017.
4. Y. Patil, *Azure IoT Development Cookbook*, 1st ed. Birmingham, U.K.: Packt Publishing, 2017.

MCE4154 E-MOBILITY [3 0 0 3]

Introduction to E-Mobility: Evolution of transportation: IC engines to electric mobility. Classification of EVs: BEV, HEV, PHEV, FCEV. Vehicle Dynamics and Propulsion Systems, Electric propulsion systems: Application of BLDC drives and Switched reluctance motor drive for EV, power electronic converters for electric vehicle applications, performance characteristics of drives, Torque–speed characteristics and drive cycles. Four quadrant operation - Regenerative braking systems, Energy Storage Systems and Battery management systems (BMS). Grid integration and vehicle-to-grid (V2G) concepts. Smart charging and renewable energy integration.

References:

1. M. Ehsani, Y. Gao, and A. Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design*, 3rd ed. Boca Raton, FL, USA: CRC Press, 2018.
2. J. Larminie and J. Lowry, *Electric Vehicle Technology Explained*, 2nd ed. Hoboken, NJ, USA: Wiley, 2012.
3. I. Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, 3rd ed. Boca Raton, FL, USA: CRC Press, 2021.
4. C. C. Chan and K. T. Chau, *Modern Electric Vehicle Technology*. Oxford, U.K.: Oxford Univ. Press, 2001.

MCE0004 SENSOR TECHNOLOGIES [3 0 0 3]

Introduction to sensor technology, classification, and operating principles of various sensors such as temperature, pressure, optical, and chemical sensors, signal processing techniques, including amplification, filtering, and analog-to-digital conversion, alongside calibration methods and error analysis, MEMS (Micro-Electro-Mechanical Systems) sensors, smart sensors, and their integration with IoT (Internet of Things) systems, emerging technologies in nanotechnology based sensor, bio-sensors, sensor for automotive, healthcare, and environmental monitoring, sensor calibration, system design, and data acquisition and industry applications in sensor technology.

References:

1. J. S. Wilson, Ed., *Sensor Technology Handbook*, 1st ed. Amsterdam, Netherlands: Newnes/Elsevier, 2024.
2. Z. Altintas and A. Barhoum, *Advanced Sensor Technology: Biomedical, Environmental, and Construction Applications*, 1st ed. Amsterdam, Netherlands: Elsevier, 2022.
3. Z. Altintas and A. Barhoum, *Fundamentals of Sensor Technology: Principles and Novel Designs*, 1st ed. Amsterdam, Netherlands: Elsevier, 2023.
4. S. Nihtianov and A. Luque, Eds., *Smart Sensors and MEMS: Intelligent Sensing Devices and Microsystems for Industrial Applications*, 2nd ed. Cambridge, U.K.: Woodhead Publishing (Elsevier), 2018.
5. O. Krejcar, A. Selamat, and P. Brida, *Smart Sensor Technologies for IoT*, 1st ed. Basel, Switzerland: MDPI AG, 2021.

MCE0005 SMART AGRICULTURE [3 0 0 3]

Sensors: Classification and characteristics, Smart sensors, Dielectric Soil Moisture Sensors, ISFET, Weather sensors. Actuators for tool automation: Motors, Solenoid actuators, Electric drives, Hydraulic and Pneumatic actuator. Plant health monitoring: Measurement of leaf health, Crop mapping, Fertilizing, Drone technology for soil field analysis and assistive operations. Technologies for farming: Water quality monitoring, micro-irrigation system, solar pump and lighting system, Fencing, Android based automation, Agricultural Robots, Standards for agriculture. Telemetry: Wireless communication modules and topology, Zig-bee, Bluetooth, LORA, Energy Harvesting technology.

References:

1. N. C. Brady and R. R. Weil, *The Nature and Properties of Soils*, 15th ed. Boston, MA, USA: Pearson, 2017.
2. E. O. Doebelin, *Measurement Systems: Application and Design*, 5th ed. New York, NY, USA: McGraw-Hill, 2023.

MCE4170 INTERNSHIP (INDUSTRY OR RESEARCH) [0 0 2 1]

Each student has to undergo industrial training for a minimum period of 45 days/ 6 weeks. This may be taken in a phased manner during the vacation starting from the end of six semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

MCE4191 WHEELED ROBOTS [3 0 0 3]

Types of wheeled mobile robots: Kinematics of wheeled mobile robot, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Dnamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots. Sensors for mobile robot navigation, Introduction to modern mobile robots: Swarm robots, cooperative and collaborative robots, mobile manipulators, autonomous mobile robots.

References:

1. R. Siegwart, I. R. Nourbakhsh, and D. Scaramuzza, *Introduction to Autonomous Mobile Robots*, 2nd ed. Cambridge, MA, USA: MIT Press, 2024
2. S. G. Tzafestas, *Introduction to Mobile Robot Control*. Oxford, U.K.: Elsevier, 2014.
3. A. Kelly, *Mobile Robotics: Mathematics, Models, and Methods*. Cambridge, U.K.: Cambridge Univ. Press, 2013.
4. S. Thrun, W. Burgard, and D. Fox, *Probabilistic Robotics*. Cambridge, MA, USA: MIT Press, 2022.
5. G. Dudek and M. Jenkin, *Computational Principles of Mobile Robotics*, 2nd ed. Cambridge, U.K.: Cambridge Univ. Press, 2020.

MCE4192 ADVANCE ROBOTICS AND APPLICATIONS [3 0 0 3]

Introduction, transformations, DH Parameters, Forward and Inverse Kinematics, redundancy resolution, Velocity kinematics and Jacobian, Singular value decomposition, singularity and manipulation ability, Trajectory planning , dynamic, Sensors and actuators as used in robotics, Basics of linear control – PD, PID controller, model based control, stability, Multi finger grasping – form, force closures, grasp matrix, Locomotion – active and passive walkers, concepts of balance, Biped Gait and Balance using ZMP, kinematics and dynamic modeling of walk, Design and Optimization of legged mechanisms. Robotics Applications.

References:

1. S. B. Niku, *Introduction to Robotics: Analysis, Systems, Applications*, 3rd ed. Hoboken, NJ, USA: Wiley, 2019.
2. M. Wilson, *Implementation of Robotic Systems*. Oxford, U.K.: Butterworth-Heinemann, 2014.
3. J. J. Craig, *Introduction to Robotics: Mechanics and Control*, 4th ed. Harlow, U.K.: Pearson, 2013.
4. M. Mihelj, *Robotics*. Cham, Switzerland: Springer, 2019.
5. A. Winfield, *Robotics: A Very Short Introduction*. Oxford, U.K.: Oxford Univ. Press, 2012.

MCE4181 SMART MANUFACTURING [3 0 0 3]

Definition and scope of Smart Manufacturing, Evolution of manufacturing technologies, Industry 4.0 principles and components, Overview of traditional vs. smart factories, Internet of Things (IoT) and its applications in manufacturing, Artificial Intelligence and Machine Learning in process optimization, Big Data Analytics for predictive and prescriptive maintenance, Robotics and Automation in smart production lines, Understanding digital twins and their role in manufacturing, Cyber-Physical Systems (CPS) and their architecture, Case studies on CPS implementation in manufacturing, Data acquisition and sensor technologies, Statistical methods and data visualization, Process optimization using real-time data, Case studies: Manufacturing analytics in action, 3D printing technologies.

References:

1. M. Soroush, M. Baldea, and T. F. Edgar, *Smart Manufacturing: Concepts and Methods*, Elsevier, 2020.
2. Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.

MCE4182 AI-BASED CONTROLLERS [3 0 0 3]

Introduction to AI-Based Control: Limitations of conventional controllers. Evolution of intelligent controllers. Applications of AI controllers for engineering systems. Fuzzy Logic Controllers: Fundamentals of fuzzy sets and fuzzy inference and controllers. Modern AI Controllers: their modeling and control. Adaptive controllers. Evolutionary Algorithms: Genetic algorithms, particle swarm optimization and Nature inspired and hybrid algorithms. Applications and Case Studies: Autonomous vehicles. Future trends in AI controllers.

References:

1. D. Driankov, H. Hellendoorn, and M. Reinfrank, *An Introduction to Fuzzy Control*, 2nd ed. Berlin, Germany: Springer, 2013.
2. K. S. Narendra and K. Parthasarathy, *Neural Networks for Control*. Cambridge, MA, USA: MIT Press, 2023.
3. S. Haykin, *Neural Networks and Learning Machines*, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2020.
4. R. S. Sutton and A. G. Barto, *Reinforcement Learning: An Introduction*, 2nd ed. Cambridge, MA, USA: MIT Press, 2018.

EIGHT SEMESTER

MCE4270 MAJOR PROJECT [0 0 0 12]

MCE4271/MCE4272 **MINOR SPECIALIZATION/ HONORS (RESEARCH PROJECT) [0 0 0 6]